

REMARKS

Applicants make the following submission to accompany a Request for Continuing Examination. Claims 1, 4-9, 14, and 18-22 are pending.

Claim Rejections—35 U.S.C. § 102/103

Claims 1, 4-9, and 19-22 remain rejected under 35 U.S.C. § 102 (b) as anticipated by or, in the alternative, under 35 U.S.C. § 103 (a) as obvious over Buffum '824. With respect to claims 1 and 20-22, the Examiner finds that the catalyst of Buffum '824 is supported on a refractory solid support containing 0.1-10% zirconium silicate as the material before firing, referencing Table 5, Carriers J and R-W. (Office Action at p. 3) The Examiner asserts that although Buffum is silent in regard to the composition comprising zirconium silicate in the final product, the carriers J and R-W in Buffum are fired at temperatures in the range of 1393-1414 °C, citing Table 4 of Buffum. The Examiner finds that these temperatures are “well below the decomposition of zircon to zirconia”, citing the present application at p. 8. (Office Action at p. 3) Thus, according to the Examiner, the end composition of zircon in the carrier after firing would be similar to the starting composition, and would at very least meet the small amounts required by claims 1 and 20-22.

Applicants respectfully request reconsideration of the rejections. For at least the following reasons, claims 1, 4-9 and 19-22 are not anticipated by Buffum '824. A claim is anticipated only if each and every element as set forth in the claim is found in a single prior art reference.

First, amended claim 1 provides that the refractory solid support, exclusive of zirconium component, is at least 95 % by weight alpha alumina, and the refractory solid support, exclusive of zirconium component, contains less than about 100 ppmw alkaline earth metal, measured as the alkaline earth metal oxide.

Buffum, on the other hand, teaches that its carrier is prepared from high purity alpha-alumina powder, *an alkaline earth metal oxide-providing compound*, a silicon-oxide providing compound, an *optional* zirconium oxide-providing compound and conventional binders/burnout

agents. (Col. 2, lines 17-21). The alkaline earth metal component of the carrier can be present in an amount from about 0.01 to about 6% by weight (measured as the oxide) of the carrier weight, but preferably, the amount present is from about 0.03 to about 5.0%, more preferably from 0.05 to about 4%, and especially from about 0.05 to about 2.0% by weight. The alkaline earth metal compounds that may be used to prepare the carriers are oxides or compounds which are decomposable to or which form oxides upon calcination. Col. 2, lines 42-54. Converting the weight percentages into ppmw, the ranges taught by Buffum are about 100 ppmw to 60,000 ppmw, 300 ppmw to 50,000 ppmw, 500 ppmw to 40,000, and 500 ppmw to 20,000 ppmw.

As illustrated by the accompanying declaration of Dr. Juliana Serafin, the presence of an alkaline earth metal component, such as calcium, greatly accelerates the decomposition of zirconium silicate, with nearly 100% conversion to zirconia when calcium is added to a carrier precursor containing zirconium silicate. (A scanned version of Dr. Serafin's declaration accompanies this submission; the originals will be submitted shortly.)

Second, amended claim 1 recites "incorporating a sufficient amount of zirconium component to enhance at least one of catalyst activity, efficiency and stability as compared to a similar catalyst which does not contain the zirconium component, said zirconium component being present in the support substantially as zirconium silicate". The Examiner has not addressed this element of claim 1. As more fully explained in the accompanying Declaration of Dr. Albert C. Liu, in Buffum, Carrier D is prepared without zirconium compounds but includes 0.4 wt% CaSiO_3 , for a calculated additive composition (expressed as the elemental oxides) of 0.21 wt% SiO_2 and 0.19 wt% CaO . The corresponding catalyst example, Catalyst C-D, is shown to have T40 of 259°C and S40 of 86.5%. Carrier R is prepared with 0.46 wt% zirconium silicate and 0.44 wt% $\text{Ca}(\text{NO}_3)_2$, for a calculated additive composition (expressed as the elemental oxides) of 0.31 wt% ZrO_2 , 0.15 wt% SiO_2 and 0.15 wt% CaO . The corresponding catalyst example, Catalyst C-R, is reported to have T40 of 260°C and S40 of 86.6%. The results for Carriers D (no zirconium component) and R (0.46

wt% zirconium silicate) are not meaningfully different — Catalyst C-D is 1°C more active while Catalyst C-R is 0.1% more efficient. If, as the Examiner contends, and which applicants do not admit, the zirconium silicate remains in Carrier R as zirconium silicate, the data fails to demonstrate the performance enhancement set forth in present claim 1. (A scanned version of Dr. Liu's declaration accompanies this submission; the originals will be submitted shortly.)

In addition, as supported by the accompanying declaration of Dr. Juliana Serafin, an ethylene oxide catalyst on a finished carrier containing zirconium silicate as opposed to one containing zirconia alone as the zirconium component demonstrates better initial activity and selectivity.

Third, the Office Action indicates that “claim 1 does not require a specific amount of zirconium silicate” and only requires that “said zirconium component being present substantially as zirconium silicate” and that “substantially” is a relative term which encompasses “any non-zero amount”. (See Office Action at p. 8).

Claim 1 of the present application does recite that the zirconium component is present in the support substantially as zirconium silicate. However, what is meant by “substantially as zirconium silicate” does not have to do with the *amount* of the zirconium component present, but *rather the composition* of the zirconium component. That is, while trace amounts of zirconia may be present, the predominant compound existing after carrier preparation and catalyst formulation is zirconium silicate, not zirconia. As taught by the specification at p. 6, lines 10-30, even the partial decomposition of zirconium silicate to zirconium oxide (ZrO_2) is a *particularly undesirable* reaction, which decreases significantly the benefits from the addition of zirconium silicate to the carrier. The specification teaches that the raw materials of the carrier must be of sufficient purity so that there is limited reaction between any components thereof and the zirconium silicate to be added during the preparation of the carrier. Further, the zircon itself must be of sufficient purity so that any impurities therein do not promote decomposition of zircon to

zirconia during the preparation of the carrier. The dictionary definition of “substantially” is “considerably”, “to a great extent”, “in essence”, “essentially” and supports the meaning as used in the specification and claim.

Buffum’s teachings refute the Examiner’s position that the “end composition of zircon in the carrier after firing would be similar to the starting composition, and would at very least meet the small amounts required by the claims” of the present application.

Buffum teaches that the alkaline earth metal oxide-providing compound is *required and desired* in its carrier in amounts *up to 6% by weight*. Buffum further teaches that the zirconium component present is *optional* in its carrier. When present, the zirconium compounds which may be used to prepare the carriers are oxides or compounds which are decomposable to or which form oxides upon calcination. (Col. 3, lines 3-13). Further, Buffum teaches that the zirconium component of interest is *zirconia*:

- (a) col. 3, lines 7-9 directs that *where zirconia is to be generated in situ*, the amount of the zirconium component should be selected to give a final proportion within certain parameters;
- (b) col. 3, lines 35-36 teach that the preferred carriers may be made by mixing a powdered alpha-alumina, calcium silicate *and zirconia* with water;
- (c) col. 3, lines 45-49 teach that the alpha alumina powder is most preferably combined with calcium silicate. These components are mixed with *zirconia or a zirconia-generating compound* (where present), a burnout/binding agent and water, formed into shapes and calcined.

Buffum treats the carriers containing zirconium silicate, zirconia, and both zirconium silicate and zirconia *before* calcination with the same broad brush: if zirconia itself is not added, zirconia is desirably generated. Buffum teaches that the alkaline earth metal component can be chosen from magnesium, calcium, strontium, and barium. Thus, while the calcination temperature range of 1350 to 1500°C in Buffum is lower than the temperature of decomposition of *pure zircon* as recited in the present application (above 1540°C), one of skill in the art, reading Buffum

as a whole, would expect from the teachings of Buffum that the zirconium silicate present in carriers J and R through W would be decomposed into zirconia. See also the accompanying declaration of Dr. Juliana Serafin, demonstrating that decomposition of zirconium silicate can occur when the zirconium silicate and calcium are present in the carrier precursor and the precursor is fired in a temperature range of 1000 to 1400°C.

The Examiner discounts applicants' arguments based on the Blumenthal reference by indicating that Blumenthal teaches that at 1118°C, a complex between calcium oxide and zirconium silicate forms. Further, the Examiner states that at 1415°C, Blumenthal teaches that zirconium silicate is still present (in both its original form and also complexed with calcium oxide). The Examiner concludes that the zirconium silicate is still present at the temperatures used in Buffum but it is just complexed with calcium oxide.

Blumenthal teaches that at 1118°C the complex product CaZrSiO_5 had started to form. At 1250°C, the mixture contained CaZrSiO_5 and free zirconia, and that from 1300°C upward, there was progressive reduction of the content of CaZrSiO_5 and increase of zirconia content. At 1415°C, only traces of zircon remained; a small amount CaZrSiO_5 and a large amount of zirconia were present.

Applicants submit that the formation of a *complex* between calcium oxide and zirconium silicate does not meet the definition of "zirconium component being present in the support substantially as zirconium silicate" as explained above, because as a chemical entity any such complex would be a distinct species from zirconium silicate itself. The specification teaches, for example, that by "zirconium silicate" the application is referring to the substance "zircon" with formula ZrSiO_4 , not just any compound that happens to contain both zirconium and a silicate. According to Encyclopedia Britannica (online), a complex in chemistry is a substance, either an ion or an electrically neutral molecule, formed by the union of simpler substances (as compounds or ions) and held together by forces that are chemical (*i.e.*, dependent on specific properties of particular atomic structures) rather than physical. Thus, the "complex" between calcium oxide and zirconium silicate involves a different substance than zirconium silicate.

For at least the reasons provided above, applicants submit that the claims are not obvious in view of Buffum. In addition, claim 1 of the present application limits the amount of alkaline earth metal compounds. The specification of the present application explains that the presence of calcium and alkaline earth metal compounds is thought to increase the decomposition of zirconium silicate to zirconia, which is not desired. Thus, Buffum teaches away from the present invention. The Examiner has not found that Buffum teaches or suggests the enhancement of one of catalyst activity, efficiency and stability from the presence of zirconium silicate as compared to a similar catalyst which does not contain the zirconium silicate.

Claims 10 and 14 remain rejected under 35 U.S.C. § 102 (b) as anticipated by Buffum '824, or, in the alternative, under 35 U.S.C. § 103 (a) as obvious over Buffum '824 in view of Weber '134. Claim 10 has been cancelled and claim 14 now depends from claim 1, rendering the rejections moot.

Claim Rejections—35 U.S.C. § 103

Claims 11-13 and 15-17 remain rejected under 35 U.S.C. § 103 (a) as being unpatentable over Buffum '824 in view of Weber '134. Claims 11-13 and 15-17 have been cancelled, rendering the rejections moot.

Claim 18 remains rejected under 35 U.S.C. § 103 (a) as being unpatentable over Buffum '824 (alternatively in view of Weber as applied to claim 14 above) further in view of Thorsteinson '140. Claim 18 depends from claim 1, and as claim 1 is patentable, so is claim 18.

Applicants respectfully submit that the pending claims are in condition for allowance.

Respectfully submitted,

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